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ACTION ARISING FROM THE SECOND SESSION

Scientific and technological aspects of
sustainable energy systems

Note by the UNCTAD secretariat

PREFACE

At its second session (15-24 May 1995), the Commission on Science and Technology for Development requested the secretariat to prepare an issues note on the identification of scientific and technological aspects of sustainable energy systems. This note is to be reviewed by the Commission at its third session in 1997 in conjunction with its future work programme.

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INTRODUCTION

1. Energy has always been an important item on the United Nations agenda. As early as 1949, it already addressed the problem of "conservation and utilization of resources" and has since played an active role in identifying sources which could provide sufficient, affordable and inexhaustible energy.¹ The first international conference to address the issue, the United Nations Conference on New Sources of Energy (Rome, 1961) explored alternative energy sources such as solar, geothermal and windpower. Marked by two worldwide energy crises and the ensuing concern over the supply security of conventional energy resources, the 1970s saw intensified discussions on new and renewable sources of energy. These discussions culminated in the United Nations Conference on New and Renewable Sources of Energy (Nairobi, 10-21 August 1981) which adopted the Nairobi Programme of Action for the Development and Utilization of New and Renewable Sources of Energy.² The application of environmentally sound technologies is also one of the key issues within the accords agreed upon at the United Nations Conference on Environment and Development (UNCED).³

2. Reflecting the need for treating energy resources in an integrated manner, the United Nations General Assembly, in its resolution 46/235 (1992) on restructuring and revitalization of the United Nations in the economic, social and related fields, established the Committee on New and Renewable Sources of Energy and on Energy for Development (UNCNRSEED), a body of government-nominated experts. This Committee assumed the mandates of both the Committee on the Development and Use of New and Renewable Sources of Energy and the Committee on Natural Resources pertaining to energy. Its primary objective is to provide policy options and recommendations to the Economic and Social Council on energy matters, including the consideration of their relation to environment and development.

3. It was in this context that the Commission, at its second session (15-24 May 1995), decided to consider energy systems as a possible area for its

¹ For an exhaustive review of energy-related activities of the United Nations system, see: United Nations (1997), *Report of the Secretary-General on an Inventory of ongoing energy-related programmes and activities of entities within the United Nations system, on coordination of such activities and on arrangements needed to foster the linkage between energy and sustainable development within the system*, United Nations, New York (E/CN.17/1997/7).

² The Committee on the Development and Utilization of New and Renewable Sources of Energy (UNCNURSE) was established as an institutional arrangement to follow up on the Nairobi Conference and to monitor the implementation of its Programme of Action.

³ See, for example: United Nations, Department of Economic and Social Development (1992), *Compendium of excerpts on science and technology related issues and recommendations, extracted from the documents adopted at the United Nations Conference on Environment and Development*. New York (unpublished working document).

future work. To this end, it requested the secretariat to submit to the Commission, at its third session, an issues note on the identification of scientific and technological aspects of sustainable energy systems. According to some members, the emphasis ought to be placed on revolutionary options such as the total energy systems approach. Recognizing the competence of UNCNRSEED in this area, the Commission also requested that the secretariat prepare the note in consultation with UNCNRSEED. The discussion during the second session also suggested that this issue could be a potential area for cooperation between the Commission on Science and Technology for Development and the Commission for Sustainable Development. The intention would be to work jointly on specific aspects of energy development and application that have not been sufficiently dealt with in other bodies of the United Nations system.¹ For the purpose of carrying out the required consultations and also to benefit from inputs by experts in the area of energy, the secretariat organized an informal meeting of experts, including a member of the secretariat of UNCNRSEED. The report of the meeting containing a summary of the discussion and recommendations for future work is given here. The secretariat circulated the report of the meeting among the members of the Commission and the suggestions received concerning both the issues taken up by the experts as well as their proposals for alternative themes for future work in the area of energy are summarized in conference room paper E/CN.16/1997/CRP.1

¹ See: United Nations, Commission on Science and Technology for Development, *Report on the Second Session (15-24 May 1995)* (Economic and Social Council, Official Records, 1995, Supplement No. 11, E/1995/31, E/CN.16/1995/14), p.5 and p. 29.

**REPORT OF INFORMAL MEETING ON SCIENTIFIC AND TECHNOLOGICAL
ASPECTS OF SUSTAINABLE ENERGY SYSTEMS**

4. The Informal Meeting on Scientific and Technological Aspects of Sustainable Energy Systems took place in Geneva on 24 and 25 October 1996. It comprised two Commission members⁵, a member from the secretariat of UNCNRSEED and two independent experts, one from the private sector and one from academia (the agenda and list of participants are given in the annex to the report.) There was a frank and constructive exchange of views on all the aspects of the energy question. The report focuses on those issues on which there was a general understanding as to their importance or relevance for consideration by the Commission. The substantive proposals for future work by the Commission on Science and Technology for Development are intended to stimulate the discussion at the third session.

A. Recognition of the problem

5. There was general agreement that energy trends in developed countries suggest a relatively weaker relationship between GDP and energy consumption. This, however, remains relatively stronger in developing countries where energy demand for satisfying basic needs and production requirements is rising. It was considered that the relationship between electricity and development might even be stronger.

6. With the threat of imminent depletion of fossil fuel having been largely discounted during the past few years, environmental considerations have become of increasing importance in the search for alternate energy sources. Carbon dioxide build-up at the global level and the dwindling forest cover at the local and regional levels are of particular concern.

7. Whereas the development and utilization of clean energy sources and technologies are imperative for all countries, access to sufficient energy is a precondition to economic development and global integration for most developing countries. The international community, therefore, is facing the twofold challenge of having to satisfy the rising needs for affordable energy systems among developing countries and, at the same time, to reduce its excessive dependence on fossil fuels. It was generally agreed that there is a broad range of technological options which, either singly or collectively, have the potential to deal in large measure with this challenge. Foremost among these options are the considerable potential for energy efficiency improvements in the conversion, transport and storage of energy as well as in its final use⁶, and the broad range of new and emerging

⁵ During its second meeting, the Bureau of the Commission requested one member of the Commission, Mr. Niels Busch, to work with the secretariat in preparing the issues note.

⁶ While the potential for efficiency improvements in developing countries, often at low investment cost, is considerable, the group's feeling was that energy consumption in industrialized countries could be further optimized through programmes designed to reduce wasteful consumption: first, because it is in industrialized countries that most R&D takes place and new processes and products are developed; and

technologies for delivering energy, including solar, wind, ocean-thermal, ocean-tidal, geothermal, biomass and hydrogen, that is scientifically proven, technologically viable, socially acceptable and environmentally less damaging⁷.

8. Given the different stages of development of these technologies and the state of the world economy which is characterized by low energy prices and limited financial resources, the challenge is to translate this potential into reality. The main issues discussed can be clustered around the following general concerns.

B. Making alternative energy sources competitive

9. There was general agreement in the Informal Meeting that the competitiveness of emerging technologies is not determined by scientific and technological factors alone. Competitiveness, being a relative concept, depends on the cost/price of the technologies/sources that are being substituted. As long as market prices of energy sources do not reflect total costs, particularly those related to environmental impacts, most new technologies, even those that are already commercially available, will remain uncompetitive. Removing subsidies applied to conventional energy technologies⁸ and internalizing the cost of environmental impacts would be one way of greatly enhancing the competitiveness of commercially available alternative technologies. However, this would have -- from a developmental point of view -- the problematic, albeit temporary, effect of raising energy prices. Positive action in favour of diffusion of alternative energy technologies would be another way.

10. For technologies not yet fully commercially available, technological factors would be more or less important. Those technologies which have already moved out of the scientific laboratories and past the technological workshop might still need to be adapted to actual working and climatic conditions. Mechanical and structural adjustments might be needed, for which further investments may be required. For example, modern

secondly, in view of the high energy consumption of the industrialized countries, small improvements in energy efficiency have a large impact on global consumption.

⁷ For a description of the various options see Johansson T. B., Williams R.H., Ishitani H. and J. A. Edmonds (1996) "Options for reducing CO₂ emissions from the energy supply sector" in *Energy Policy*, Vol. 24 pp. 985-1003; and IPCC(1996) *Climate Change 1995: Impacts, Adaptations and Mitigation of Climate Change: Scientific-technical Analyses: Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change*, New York.

⁸ Annual subsidies on conventional energy sources/technologies are estimated to total more than US\$ 300 billion. These subsidies involve tax exemptions, financial support, price support etc. in the production and use of conventional energy. A. Shah, (1994), "Energy pricing and taxation options for combatting the greenhouse effect" in *Climate Change: Policy Instruments and Their Implications*, Proceedings of the Tsukuba Workshop on IPCC Working Group II, 17-20 January; OECD (Organization for Economic Cooperation and Development) (1992), *The Economic Cost of Reducing CO₂ Emissions*, OECD Economic Studies Special Report No. 19 OECD, Paris. For examples of types of subsidies provided by some OECD countries, see IEA(International Energy Agency) (1993), *Taxing Energy: Why and How*, OECD, Paris.)

electricity-producing windmills, which have been in use for some time now, continue to experience problems, including structural ones. There is also the problem of by-products, such as sulphuric acid from photovoltaics, for which proper disposal could be costly. Like all new technologies, novel energy technologies have to undergo a period of adaptation before they can become technologically viable and readily adaptable. It is only after these initial problems are resolved that such technologies can be mass-produced and thus become commercially competitive with conventional sources. The slow progress in the R&D and commercialization of technologies may also be attributed partly to the low pricing of conventional sources. The role of the private sector at the pre-competitive stage of development is critical and private firms, which are under strong pressure for rapid return on investments, are unlikely to invest in these technologies if they perceive that benefits are distant.

11. Regarding technologies that are still at the stage of scientific research and for the development of which government plays a greater role, it was pointed out that investment in R&D has been declining in the 1990s.⁹

12. The experts felt that, in view of the fact that the costing and pricing of energy sources/technologies is a dynamic process, decisions on optimal systems ought to be based on maximization of net present value.¹⁰ Costs of present and alternate energy systems need to be compared. A new energy source would replace an old one only if the new alternative is economically viable. Energy alternatives could become attractive as their costs decline as a result of economies of scale and as the real costs of traditional energy technologies are reflected in their price as, for example, through carbon taxes.

C. How to increase the share of alternative sources of energy in the energy systems

13. The experts felt that increasing the application of renewable sources of energy would better help to diversify energy systems than is possible with current patterns of energy production and consumption.¹¹

⁹ Aggregate government R&D expenditure of IEA countries has declined, in real terms, by 21 per cent between 1985 and 1995. The decline has been observed in the individual expenditures of most countries. See OECD/IEA (1996), *Energy Policies of IEA Countries: 1996 Review*, OECD/IEA, Paris. One could argue that, in view of the liberalization of most economies, the decline in public expenditures has been compensated by increased investment by the private sector. It was felt that this, however, has not been the case.

¹⁰ Money now is worth more than money in the future, because it can be invested to produce a greater sum of money in the future. For example, US\$105 in a year's time has a present value of US\$100, if the interest rate is 5 per cent. Thus, the net present value of an investment is the difference between the capital cost of the investment and the present value of the future cash flows to which the investment will give rise.

¹¹ While no energy sources or technologies were *a priori* excluded, the discussion focused on renewable energy sources/systems as sustainable alternatives to fossil fuels. Thus, nuclear energy and large-scale hydro-power projects, which have been

14. As a general principle, however, it was agreed that there was no single solution to the energy dilemma. Thus, conventional energy sources will be continue to be used even in the medium and the long term. The application of sustainable energy systems is not just a matter of primary concerning developing countries; it is a task of global responsibility. Considering that the use of energy is one of the main factors contributing to global environmental degradation, the adoption and application of environmentally sound energy technologies require concerted action on the part of the entire global community. Strategies on how to pursue available options were the major thrust of the discussion during the meeting and are summarized below.

(i) *The need for removing institutional, policy and financial constraints*

15. This includes the building of capabilities to use sustainable energy technologies on a global basis. It requires enhancing scientific and technological capacity in diverse fields such as, *inter alia*, energy use, adaptation, maintenance, organization, information dissemination, management. Acquiring adequate equipment to measure the effective use of energy along with quality control systems will be needed, particularly in developing countries. Furthermore, the level of technological capacities of recipient countries is a determining factor in decision-making, since it affects not only the level and type of technology but also its cost in terms of installation and maintenance.

16. General awareness of adverse environmental consequences needs to be enhanced. There is also a need for training energy specialists to take a systems approach to meeting energy requirements.

(ii) *Overcoming bottlenecks*

17. The process described above will not be automatic. It requires the allocation of financial resources, the development of technical and scientific skills to improve the efficiency of existing systems and correction of infrastructural problems. These have to be assessed on a national level. Economies in transition often cope with a rigid and heavy infrastructure that does not provide for efficient use of existing energy systems. Least developed countries, on the other hand, face the challenge of small ageing power plants, obsolete urban electricity grids or inadequate distribution networks in rural areas; all these factors raise the cost of delivered energy. Thus, resolving problems related to energy storage, distribution and/or transportation are important elements in harnessing available energy resources to meet rising requirements.

(iii) *The need for differentiated solutions*

18. Changing energy systems is a complex task that often requires changes in the entire economic structure of a community. For example, in economies in transition, local communities often survive economically because of existing, albeit inefficient, energy systems. Even when a new and profitable energy system is commercially available, considerable difficulties, ranging from sub-optimal use of resources to socio-political

under broad criticism over many years, were not specifically addressed by the experts.

factors, need to be overcome. The fast growth of energy demand combined with financial constraints can lead some countries to continue using or even to select energy systems that are neither cost effective nor environmentally benign simply because better alternatives are not readily available. Thus, energy solutions should be differentiated according to individual country needs and possibilities and should consider factors such as geographical situation, level of development etc. An energy system that is appropriate for one country at a certain stage of development may not be right for another. A right mix of energy should be found for each country.

(iv) *The need for increased flexibility and integration of multiple energy systems*

19. Given the increasing availability of new energy systems, it is hard to predict which energy form will ultimately be dominant, most efficient, profitable and also environmentally benign. Therefore, a flexible approach is needed that allows for different options to be pursued rather than embarking on large-scale projects that may require huge investments but may not be viable economically, ecologically and socially in a few years' time. Energy systems that can be adjusted relatively easily to changing market conditions might be the most cost-effective approach to meeting energy demand in the present situation. Integrated systems consisting of both conventional and alternate energy options offer more possibilities for adjustment to new technological developments. They allow the mix of primary energy sources, the combination of centralized and decentralized systems, and can be kept relatively small. Moreover, they can be linked effectively to other systems such as water management and parts of the food sector. Investment costs for integrated systems, however, remain high since they are based on complex installations while, on the other hand, their operating costs are often low. However, studies of energy systems that cope successfully with interlinked networks of different energy sources have been reported in the literature.

(v) *The need for an energy policy*

20. Most OECD countries have *de facto* energy policies.¹² Similarly, economies in transition and most developing countries have made considerable investments in the development of national energy infrastructures and the formulation of national energy strategies. The sustainability of energy systems became the focus of concern worldwide when world crude oil prices spiralled upwards during the 1970s and early 1980s. This interest resulted in significant energy savings and improvements in the efficiency of energy use. However, more recently, interest in new energy technologies, and in energy more generally, seems to have waned in many countries as concerns about supply security and costs are no longer as strong as they were during, and immediately after, the energy crises of the 1970s. Yet, as the discussion showed, there are important technological and economic issues which call for coherent energy policies both at the national and international levels. The availability, cost and diffusion of sustainable energy technologies will depend strongly on policy, including

¹² One expert expressed doubts about the extent to which this assertion applied to the United States where he felt that policies were reduced to certain regulatory functions rather than to a conscious energy development strategy.

on energy-costing policy that allows environmental impacts to be reflected in pricing structures. The integration of many different energy systems and the optimization of their size are complex issues which also need to be addressed by policy.

D. Potential areas of work by the CSTD

21. The discussions in the previous sections point to the crucial role of policy in providing incentives, raising awareness and developing appropriate infrastructures. In order to formulate policy in a technologically and economically dynamic environment, continued monitoring and analysis at the national and also the international level are needed. The globalization of environmental concerns, the growing linkages among different energy systems and the increasing variety of traded energy forms and technologies open up more possibilities for, as well as necessitate new forms of, international cooperation in this area. By focusing its work on energy and sustainable development, the CSTD can contribute to these objectives.

22. The experts identified a number of areas where further work is needed, which the CSTD may wish to consider. These include the following:

- (a) Reviewing current R&D on energy and analysing it from the point of view of its contribution to developing environmentally safe/sound, and economically equitable, energy paths, paying particular attention to the needs of developing countries;
- (b) Exploring the broad set of innovative possibilities available through integrated and flexible systems that link traditional and alternate energy options and examining their relevance for developing countries. These possibilities have not been investigated thoroughly. Here, new ground could be broken by the Commission. This work should be complemented by demonstration activities and technological capability-building activities in energy management, especially in the area of efficiency improvements;
- (c) Addressing infrastructural problems of countries having structures that need wide-ranging adjustments as well as of those where infrastructures have not yet been developed;
- (d) Reviewing national experiences with energy policy-making;
- (e) Identifying and analysing energy issues relating to specific sectors such as *the transportation sector*. The experts considered that this is a sector where improvements could contribute the most to reducing the stresses on the environment and to a more efficient use of energy. It was felt that the CSTD should address the issues of transportation systems rather than energy use by specific transportation means;
- (f) Identifying and analysing energy issues relating to specific energy sources such as *modern biomass technologies*, which are attracting considerable attention for their potential of providing significant amounts of renewable energy. It is important to evaluate the magnitude of this potential and to dispel fallacies surrounding it. There is also a need to address biomass management at the global level.

ANNEX

**INFORMAL MEETING ON SCIENTIFIC AND TECHNOLOGICAL ASPECTS
OF SUSTAINABLE ENERGY SYSTEMS
(Geneva, 24 and 25 October 1996)**

Annotated Agenda**Item 1: Introductory statements**

The Chief of the Innovation and Investment Policies Branch will open the meeting, followed by brief presentations by Mr. Busch, member of the Commission on Science and Technology for Development (CSTD), and by the secretariat, on the mandate of the Commission, the objectives of the report to be prepared and the task of the present Expert Group. At this point, Mr. Shane, member of the secretariat of the Committee on New and Renewable Sources of Energy and on Energy for Development, will brief the Group about the Committee's work programme and activities.

Item 2: General discussion

The conceptualization of sustainable energy systems:

- current thinking on this issue;
- energy and development nexus;
- the energy dilemma: the gap between the current energy consumption patterns and the unsustainability of current pattern of supply;
- criteria of sustainability.

Item 3: Supply-side issues

Scientific and technological aspects of primary energy supply and energy transformation:

- the role of technology in making primary energy production environmentally friendly;
- technology and the development of new sources of energy;
- technological solutions to the energy dilemma: scenarios for the 21st century;
- the special case of electricity.

Item 4: Demand-side issues

Scientific and technological aspects:

- in improving the efficiency of energy use as a means of attaining sustainable energy systems;
- in reducing environmental impacts of improved energy use.

Item 5: Infrastructure requirements and policy issues

- Infrastructure requirements as a determinant of sustainable energy systems:

- interconnected systems;
- decentralized systems.

- Energy-related technological infrastructure:

- the capacity to upgrade technologies;
- the capacity to acquire, adapt, effectively use and modify imported technologies;
- the capacity to undertake R&D and diffuse new technologies;

- Policy-related issues:

- the need for national energy policy;
- international cooperation in promoting sustainable energy systems: effective ways of addressing issues such as proprietary rights, financing schemes and joint development and transfer of technologies.

Item 6: *Identification of main elements for the report: synthesis of discussion covered under items 2-5*

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Sustainable Energy Systems for Development
(Geneva, 24 and 25 October 1996)

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SUBSTANTIVE THEME: INFORMATION AND
COMMUNICATION TECHNOLOGIES FOR DEVELOPMENT

Report of the Working Group on Information and Communication Technologies for Development

Pursuant to Economic and Social Council resolution 1995/4, the Working Group on Information and Communication Technologies for Development has completed its work. The report of the Working Group is submitted to the Commission for its consideration.

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Executive summary

1. In some parts of the world, information and communication technologies (ICTs) are contributing to revolutionary changes in business and everyday life. Other parts of the world, however, have hardly been touched by these technologies. There is little question that their social and economic potential is enormous, but so too are the risks that those without the capabilities to design, produce and use the new products and service applications may be disadvantaged or excluded from participating actively in their local communities and in the global information society.

2. The United Nations Commission on Science and Technology for Development (UNCSTD) decided to address the ICT and development topic at its third session in May 1997. Its Working Group's review of the evidence regarding the implications of ICTs for developing countries and countries in transition led it to conclude that there are substantial indicators that the new technologies are transforming some sectors of society. There is a very great risk, however, that if effective national ICT strategies are not put in place, the capacity building that is needed in order to benefit from these technologies may not occur.

3. The Working Group has concluded that governments and other stakeholders must be called upon to design new roles for the public and business sectors to enable ICTs to be harnessed to economic, social and environmental development goals. It therefore recommends that:

Each developing country and country in transition establish a national ICT strategy. Where such strategies already exist, they should be reviewed to ensure that they take note of the guidelines proposed by the UNCSTD Working Group;

Immediate action be taken by national governments to establish a task force or commission or to ensure that another entity is charged with establishing the guidelines for national ICT strategies. Reviews should be undertaken over a six-month period and a report should be prepared by each government outlining the priorities of its national ICT strategy, the mechanisms for continuous updating, and the procedures for implementation of the components of the strategy. Progress on the implementation of this recommendation should be reported to the next session of the Commission in 1999;

Each agency of the United Nations system review the financing, production and use of ICTs for social and economic development in their area of responsibility. This review should monitor the effectiveness of new forms of partnerships in the ICT area, and address the capability of each agency to provide technical assistance in that area. This needs to happen so that the United Nations system can be in the forefront in helping developing countries and countries in transition to implement their national ICT strategies.

4. Furthermore, the Working Group recommends that UNCTAD prepare a study for the next session of the Commission on the implications of new forms of revenue generation, focusing especially on those involving ICTs which may support social and economic development priorities. In particular, it should report on the implications for developing countries and countries in transition of the ongoing discussions and studies on a "bit tax".

5. Also, the Working Group suggests guidelines that should be noted by national governments, other stakeholders, and the agencies and organs of the United Nations system. These are intended to help developing countries and countries in transition design new roles for the public and business sectors so as to enable ICTs to be harnessed to economic, social and environmental development goals.

1. Introduction

6. There is intense debate today about the potential of science and technology to transform the lives of the citizens of the world. The technologies that give rise to this are the information and communication technologies (ICTs). These are already transforming the way in which many large and some small firms and national governments conduct their business. They are certainly contributing to rapid changes in the world economy, where the production of goods and services seems to pay less and less attention to national boundaries. New services, robotics, computer-aided design and new management techniques, made possible by ICTs, are all contributing to changes in the competitiveness of both firms and nations.

7. Equally dramatic are the implications of these technologies for the social and entertainment sectors. Education, health care, transportation, employment and leisure time are all undergoing revolutionary changes through the introduction of these new technologies. The impact of these changes is being felt in the industrialized countries; at the same time, however, they are also benefiting certain sectors of many developing countries and countries with economies in transition.

8. Some of the contributors to the debate suggest that it is only a matter of time before market mechanisms and new forms of international co-operation ensure that all the world's citizens can enjoy the benefits of the global information society. There is little need, they argue, for urgency or special ICT measures by governments and other stakeholders. They recognize, however, that, with increased market liberalization in many countries, the role of governments is changing.

9. Others acknowledge that changes are occurring in society as a result of ICTs, but they suggest that the truly transformative nature of these technologies has been exaggerated. There is a huge potential for transformation, but there are also major problems. The new technologies may be destroying more jobs than they create; there is a great risk that they will in fact widen the gap between rich and poor; and the huge capital investments required to strengthen national capabilities to produce and use ICTs may divert both public and private resources from other activities which could have greater development impact.

10. Those taking the latter view sometimes urge developing countries and countries in transition to exercise caution lest they embrace the new ICTs too enthusiastically and thus risk becoming disillusioned when they do not resolve all their development problems. Alternatively, they call urgently for distinctive national ICT strategies which will maximize the benefits and minimize the risks of these technologies. Governments and other stakeholders must be called upon to design new roles for the public and business sectors to enable ICTs to be harnessed to economic, social and environmental development goals.

11. In view of the acknowledged importance of ICTs as a generic technology for developing countries and countries in transition, and to help governments in developing countries and countries in transition understand the complexities of the present debate and guide them in their responses, the UNCSTD decided to address the ICT and development topic at its third session in May 1997. In preparation for this discussion a Working Group was established to review the evidence of the implications of ICTs for development. The present document is its report.

12. At its first meeting the members of the Working Group delineated some of the broad parameters of the issues of relevance to their work. A search of existing sources of information on policies and the application of ICTs to meet a wide range of development objectives was complemented by the commissioning of a set of papers from the United Nations University-Institute for New Technologies (UNU-INTECH) and Colombian Government

Institute for Science and Technology (COLCIENCIAS). These papers were supplemented by papers prepared for two workshops hosted by UNU-INTECH on the information revolution and on economic and social exclusion in developing countries. A meeting in June 1996, convened jointly by the International Development Research Centre (IDRC) and UNCSTD, was used to enable several members of the Working Group to discuss future scenarios for the diffusion of ICTs and to consider policy actions that could be taken. A meeting in December 1996 of a small group of members of the Commission on Science and Technology for Development, members of the secretariat and representatives of the lead technical institutions considered the results of the work and prepared the outline of this report. The draft text was reviewed and revised at a meeting of the Working Group in January 1997.

13. The Working Group reviewed more than 60 papers on different aspects of the implications of ICTs for development. It was unable to reach firm conclusions about many aspects of the debate. There is substantial evidence that the new technologies are transforming some sectors of some societies. Some firms have dramatically improved their competitiveness by using ICTs, and some countries are increasing their export strengths in the ICT sector. Governments are becoming more efficient in providing services to their citizens using ICTs. The Working Group learned about how ICTs are permeating almost all sectors of society and, in many cases, affecting people's lives positively.

14. Furthermore, it discovered that the impact of these technologies on economies and societies is not as deep or pervasive as the debate about the benefits of the global information society sometimes makes it appear. There are still very many people whose lives have barely been touched by ICTs and others who have suffered unemployment or difficulties as a result of the introduction of ICTs. For example, there are still large numbers of schools without access to ICTs, and many educational curricula do not provide the training needed to produce the new technologies, to customize them to local needs or to use them effectively. Capacity building in this respect is really only just beginning in many countries.

15. Overall, after reviewing the evidence, the Working Group concluded that, although the costs of building national information infrastructures and joining the global information infrastructure are high, the costs of not doing so are likely to be much higher. As yet, the evidence that ICTs will transform the world and bring benefits to all its citizens is inconclusive, but there is sufficient evidence of their potential to indicate that it would be wise for all governments and other stakeholders to take the steps needed to access and use these technologies. For this reason, the Working Group recommends that each country establish a national ICT strategy.

16. This report is structured around two central themes. The first is that developing countries and countries in transition are starting from very different positions in developing their own distinctive national information infrastructures (NIIs) to support their development objectives and link their societies with the global information infrastructure (GII). The second is the need to find effective ways of maximizing the benefits of ICTs and minimizing their risks.

17. In section 2, we examine ICTs and their potential for transformative social and economic impacts. The section highlights the innovations and opportunities for producers and users of these technologies and the problems of gaining access to the new technologies and services. It examines the range of applications for businesses and citizens, and the importance of ICTs for scientific and technical research. The potential social and economic benefits of ICTs and measures that would enable developing countries and countries in transition to shape their NIIs more effectively are also considered.

18. Section 3 focuses on the importance of assessing the benefits and risks of ICTs, and reviews some of the steps being taken nationally and internationally to establish ICT strategies. To understand more clearly the changes in the global environment and the possible responses by national governments and other stakeholders, the scenarios that emerged from the Working Group's work are presented briefly in section 4. These scenarios were helpful in assessing the most likely future implications of ICTs and in formulating the Working Group's recommendations and guidelines for the development of national ICT strategies. The latter are presented in section 5.

19. This report emphasizes the need for national ICT strategies to encompass the technologies as well as the scientific, technical and engineering knowledge and management techniques used in creating, disseminating and using information. They should take into account the ways in which ICTs give rise to new forms of social, economic and cultural interaction as well as exclusion. Priority needs to be given to policies, regulations, education and training and technology assessment programmes that enhance the capacity to design and use ICTs creatively. There are no generic "best practice" models for these strategies because of the very great differences among developing countries and countries in transition. There is, however, a common need to build new coalitions of resources and enable the business sector to play an increasing role in all aspects of ICT development. The role of government and the public sector is increasingly important in supporting new forms of market facilitation, introducing effective regulation, promoting "stakeholder dialogues" and providing public services appropriate to local conditions.

20. Although the coming decade will not see the eradication of the gap between rich and poor, if governments and other stakeholders design and implement effective ICT strategies, ICTs will help to reduce the gap for some of those who are disadvantaged or marginalized. Special treatment is likely to be needed for the least developed countries, and especially for countries in sub-Saharan Africa and in rural areas, to provide the necessary financial resources, physical infrastructure and knowledge base.

2. ICT innovations and opportunities

21. As advanced computer, telecommunication and audio-visual technologies become more widely accessible, a vast new range of applications and opportunities is emerging. The convergence of these technologies as a result of rapid innovation and the availability of high-speed networks are providing new opportunities for the generation and management of information that can be tailored to users' needs and contribute to development goals. To appreciate fully the scope and implications of the transformations that are under way, it is helpful to consider the heterogeneity of the technologies and services in the ICT revolution, and to consider the opportunities and constraints facing the producers and users of ICTs. National capabilities need to be strengthened, and scientific and technical knowledge is playing an important role in ensuring that developing countries and countries in transition are able to benefit socially and economically from ICT innovations. The many new applications of ICTs provide a potential basis for ensuring that these countries will be in a position to shape their own distinctive NIIs.

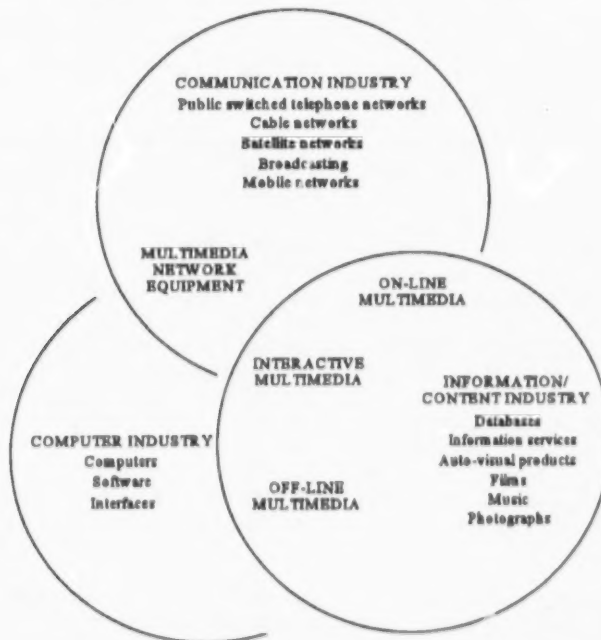
2.1 Convergent and revolutionary technologies

22. ICTs include a heterogeneous series of technologies, infrastructures, products and services. The ICT sector includes semiconductors, traditional voice telephony technologies, and technologies supporting high-speed data and audio-visual systems, stand-alone and networked computers, and packaged and customized software. Nearly all ICT sectors are converging on digital technology. Access to huge volumes of digital information is available

through the use of compact discs and CD-ROMs and other digital storage media.

23. The next step in developing the NII and connecting it to the GII is development of the ability to transmit this information from one site to another. Ever higher capacity networks can carry information in any format, including video, images, sound and text, and these systems are being installed in the backbones of many national networks. In some industrialized countries, these "highways" are reaching into homes and the premises of small and medium-sized enterprises as well as the largest firms. The key components of the converging ICT system are shown in figure 1.

Figure 1. Converging ICT systems



Source: Devotech (1995), 'Development of Multimedia in Europe', Report to the European Commission, January.

24. The Internet is just one of the components of the GII, but it is the most visible sign of rapid changes in the diffusion and use of ICTs. By early 1996, the number of computer hosts connected to the Internet was estimated at more than 9 million throughout the world. Access to these networks is provided by computer terminals or interactive television connections; this equipment is becoming cheaper and therefore more widely available.

25. There is no single technological pathway building national infrastructures or connecting to the GII for businesses or consumers. Some countries are relying more heavily on the fixed telecommunication infrastructure, while others are introducing mobile and other radio-based networks. From their different starting points, developing countries and countries in transition will select different ways of joining the global information society. Their choices will depend on their past NII investment, their hardware and software production capabilities, experience with the customization of these products and the capital available to promote new ICT strategies.

26. Important choices must be made as to which components of this heterogeneous set of technologies and services should be produced domestically, and decisions are needed to ensure that ICTs are used to contribute to national development goals. The variety of products and services and the differences in the economic and social conditions in developing countries and countries in transition make it extremely difficult to generalize about the technologies and human resource capabilities that will be responsive to national goals. The capability to assess and evaluate the benefits and risks of various alternatives is therefore essential.

2.2 ICT production opportunities

27. ICT producers include creators and owners of content, packagers and intermediaries who provide commercial services, network operators, and developers of various kinds of equipment, including semiconductors, switching and transmission equipment, personal computers and televisions. They include firms in the telecommunication, broadcasting, publishing, computing and software industries.

28. The production of semiconductors and the hardware components associated with the "microelectronics paradigm" relies on a relatively expensive telecommunication infrastructure and computer hardware components. It requires substantial amounts of capital, significant expertise and technological resources, and it has long development lead times. Products are often developed internally within the large ICT companies and they frequently involve non-standard interfaces to secure software and content royalties. Although the barriers to entry for the production of computer hardware components are diminishing, considerable attention is now being focused on the characteristics of software development which, in contrast, emphasizes human creativity, and the emerging "software paradigm" is associated with relatively low-entry costs. Capital requirements are generally lower, but production is dependent on a combination of technical and creative skills. Lower barriers to entry mean that many smaller companies can engage in applications development, but success is greatly dependent on the availability of venture capital or other forms of start-up funding.

29. In spite of falling costs and the new entry opportunities associated with software development, most ICT development work continues to be initiated in a small number of countries and this influences the conditions of ICT development and use world-wide. During 1994, for example, the top 20 manufacturers of public network equipment generated approximately US\$ 110 billion in revenues (Sirius Consulting)¹. Of this amount, some US\$ 86 billion was generated by only 10 firms, located in just seven countries. OECD data on the top 100 computer firms show that of a total of just under US\$ 280 billion in revenues generated in 1992, nearly 60 per cent was generated by firms based in the United States, Japan and European Union countries.

30. Countries such as China, Indonesia, Malaysia, the Republic of Korea, Singapore and Taiwan Province of China, have become very successful in producing ICTs, including consumer electronics and computer technologies. Countries such as India have found ways to exploit software development markets by adding value through assembly and testing. India has been successful in capturing a small but growing share of the world export market for software. In this case, start-up funding from a United Nations agency provided the basis for a major expansion into export markets based on cost advantages and, more recently, on quality. The sustainability of these ventures needs to be kept under continuous review, as new generations of

¹ Figures extracted from data compiled by Sirius Consulting, Montpellier, France, published in *Communications Week International*, 27 November 1995.

components, including microchips and PC motherboards, may require less labour-intensive techniques.

31. These experiences in the ICT sector raise questions about the appropriate balance between hardware and software production and the critical mass of skills necessary for sustaining effective ICT use. There are also questions about whether success in export markets can be translated into the wider diffusion and use of ICTs in domestic markets. The prices of PC components (microprocessors, memories and hard drives) are falling and the costs of some telecommunication services are decreasing with market liberalization. Price reductions are closely linked to government policy measures that lead to the reduction of tariff barriers and barriers created by regulations. Developing countries and countries in transition should assess their existing technological capabilities and relative cost advantages and should target markets for an appropriate combination of production, maintenance and assembly, and applications. These assessments would be managed more effectively if a national ICT strategy were in place.

2.3 ICT access, constraints and user capabilities

32. The gap in the accessibility of the basic telephone infrastructure has been recognized for many years by high-level representatives of governments and industrial communities. In 1984, the widely circulated "Maitland Report" observed that:

"in the industrialized world telecommunication is taken for granted as a key factor in economic, commercial and social activity and as a prime source of cultural enrichment. The pace of technological innovation is such that inhabitants of the industrialized world look forward to enjoying the full benefits of the so-called 'information society' by the end of the century. The situation in the developing world is in stark contrast. In a majority of developing countries the telecommunication system is inadequate to sustain essential services. In large tracts of territory there is no system at all. Neither in the name of common humanity nor on grounds of common interest is such a disparity acceptable". (International Telecommunication Union, *The Missing Link: Report of the Independent Commission for World-wide Telecommunications Development*, December 1984)

33. The Maitland Report estimated that a total investment of about US\$ 12 billion a year would be needed to meet its target for telecommunication investment in the developing countries by the beginning of the twenty-first century. That target was for all the world's people to be brought within easy reach of a telephone.

34. The scale of the investment required to gain full access to the GII is substantial. For example, to convert some 20 per cent of the existing global telephone-user base to receive video services would cost about US\$ 130-260 billion, a figure that doubles if the costs of network services and customer premises equipment are added².

35. Despite major investment initiatives in some countries and regions, the stark differences between the developed and developing areas in the penetration of telephone services remains today as shown in figure A.1 in (appendix 2). The extension and upgrading of the telecommunication infrastructure in the developing regions of the world requires heavy investment. Problems with regard to the financing of the telecommunication infrastructure include the presence of state monopolies, low efficiency, the need for tariff restructuring and new regulatory regimes. Demand is very

² International Telecommunication Union, *World Telecommunication Development Report 1995*.

difficult to quantify for the marginalized and excluded segments of the population. Differences in the patterns of investment and revenue generation may account for some of the variations in the diffusion of basic telephony and advanced services. Figure A.2 (appendix 2) shows that the ratio of investment to revenue is highest among the developing countries in Asia and Oceania, and considerably lower in both the industrialized and developing African countries. These ratios reflect the priority given to reinvestment in the NII by national network operators in these countries and other priorities of national governments.

36. One of the platforms that enables users to access the GII is the personal computer (PC). But access to local and international sources of information requires not just reliable PCs. It also requires relatively inexpensive network access and usage charges, and unless access is provided via a business, education or research institution network, a modem is needed. The gap in penetration rates for PCs is shown in figure A.3 (appendix 2) for countries in the developed and the developing world. The ICT diffusion gap is present not only for household and business telephones and PCs but also for payphones, mobile subscriptions, television sets and fax machines (figure A.4, appendix 2).

37. The Internet has been promoted as a network that could provide a means of joining the GII. Although estimates of the rate of growth in the use of the Internet are very high, the highest growth rates are concentrated in the richer countries, and especially in the developed countries in the Americas and Oceania (figure A.5, appendix 2). One of the Global Information Infrastructure Commissioners, Olof Lundberg, Chief Executive Officer of ICO Global Communications, has observed that some 89 per cent of people using the Internet are from the highest-earning and most educated sections of the populations³.

38. Internet host computers which provide the gateways to the GII are mainly located in the United States, Canada and Western Europe, as shown in figure A.6 (appendix 2). The rest of the world accounts for only 9 per cent of these hosts. This concentration of host activity in the developed world has implications for the costs of accessing information and for the types of services that are available. It tends to accentuate the predominance of anglophone traditions embedded in the content of these services. The location of hosts also has implications for scientific and technological research. Internet host services in the industrialized countries generally accommodate a disproportionately small number of publications from the developing countries and countries in transition, limiting the extent to which researchers, policy makers and citizens can learn about themselves, their own needs and each other's solutions to common problems.

39. Overall, access to ICT networks and services and the use of ICT equipment in the developing countries and countries in transition is still very limited as compared with the industrialized countries, and disparities are also evident in data for the Central and Eastern European countries (table 1, appendix 2). Countries with limited financial resources often need to choose between promoting the extension of the NII to increase telephony penetration rates and promoting the diffusion of high-capacity networks. This is especially true of the least developed countries and the rural areas of countries in sub-Saharan Africa. The availability of street-side "kiosks" in these countries may help to provide access to networks and services that are responsive to people's needs.

2.4 *ICT applications for development*

40. Public-sector ICT applications include distance learning and continuing professional development; road traffic management; disabled support services; air-traffic control; health-care networks; electronic tendering for contracts; and public administration applications. ICT applications are increasing the efficiency of public services in areas such as automated or computer-assisted translation; "one stop shopping" for government information; applications designed to limit environmental degradation; citizens and emergency support services; and services to support inter-community meetings. The application of advanced ICTs in developing countries is playing an important role in contributing to improved food security, weather forecasting and the understanding of disease pathology. ICTs are also being used to support humanitarian initiatives. In many areas, non-governmental organizations are working in partnership with development institutions and the agencies of the United Nations system. A wide range of consumer services is being developed for entertainment markets as well as home banking and teleshopping services. Many of these services have the potential to enable marginalized populations to participate more actively in the social and economic community.

41. Applications for business include automated information processing systems and systems for data entry and storage. Companies are adopting distributed computerized systems that support computer-aided design and manufacturing. Corporate networks (and Intranets) are providing the infrastructure for teleworking as well as for teamwork using computer-supported-cooperative-working software. The business sector is relying on ICTs for automated information-processing systems, electronic commerce and distributed computerized systems for stock control, just-in-time manufacturing, computerized numerical controls and robotics. All these applications enable companies to participate more effectively in the local, national and global economy.

2.5 *Scientific and technical knowledge and ICTs*

42. ICTs are an essential component of all facets of scientific and technical research and development (R&D). The ability to innovate and to find new ways of living in the emerging global information society requires new national strategies to take advantage of developments in ICTs. Scientific and technical research plays an important role in the production and use of ICTs in all sectors of the economy, and the use of ICTs is becoming a crucial aspect of the process of conducting scientific and technical research.

43. The expansion of national infrastructures and connections to the GII are enabling access to databases holding technical and scientific information. As research laboratories in the business and public sectors increase their connectivity to the GII, access to these databases is becoming essential to the design and production of ICTs and their use in traditional manufacturing and the service sectors of the economy. Computerization of search techniques using intelligent agents can put the latest technical information in the hands of scientists, engineers and other experts. However, like the Internet hosts, on-line scientific and technical databases are heavily concentrated in the industrialized countries.

44. The development of the capabilities to assess this information and to customize it to local circumstances is essential for developing countries and countries in transition. The large resource of indigenous scientific and technical expertise within many of these countries could be shared more effectively by developing the NII, but the costs of initial development are high, especially when translation is necessary.

45. ICTs can be applied to strengthen all aspects of national systems of innovation. For example, computerized support systems can aid in the assessment, selection, application, adaptation and development of a broad range of technologies and services, including ICTs themselves. As the NII is strengthened collaboration between research institutions in the "North" and the "South", and "South-South" collaboration, can be strengthened. Growing evidence of the increasing importance of international R&D collaboration in the industrialized countries suggests that action is needed to ensure that developing countries and countries in transition contribute to, and share in, such collaboration.

46. The role of ICTs in supporting and improving the national absorptive capacity for imported technology is especially important. Applications in education and training are strengthening primary, secondary and university education systems. However, capacity building requires a literate population and familiarity with the tools and techniques of technology assessment. Strategic planning and the selection of niche markets for the exploitation of scientific and technological expertise can benefit from the use of ICT-based "expert systems" and scientific instrumentation. To achieve those goals, quantitative and qualitative indicators are needed to monitor the effectiveness and diffusion of new applications.

47. R&D involving ICTs is yielding applications in areas such as integrated resource management, coordinated medical centres, environmental research and land management, biodiversity monitoring, biochemical engineering and molecular medicine, solar water heating and other energy conservation applications, and laboratory-based testing and standardization. ICTs are contributing to the automation of production activities, including weaving and knitting machines, sewing machines, numerically controlled machine tools, and continuous process control in chemical and petrochemical plants. These technologies can also play a much greater role in increasing the awareness of the scientific and technical research community through the use of sites on the World Wide Web, and they provide access to discussion fora in sectors such as agriculture, mining and forestry.

2.6 Benefiting socially and economically from ICT innovations

48. ICTs are having a major impact on all aspects of social, cultural, economic and political life. They have the capacity to alter fundamentally the ways in which individuals and communities conduct their everyday lives and their business activities. When ICTs support public services, the absence of access to networks can lead to new forms of exclusion and greater deprivation.

49. Cultural, social and business norms and values change as people begin to use ICTs. For example, the increased speed of communication and electronic transactions can lead to faster decision-making. But world-wide network connectivity also magnifies the range of services and price information that is available, leading to greater complexity in economic decision-making. Decision support systems can facilitate economic decision-making, and access to network services can bring distant or local communities into closer contact. The anonymity of communication increases with the diffusion of ICT services since messages can pass through networks leaving no record of origin, destination or content which can be audited. Messages and content can be easily copied or changed. As ICT-based services are diffused more widely, computerized crime presents problems for policy makers, and measures are needed to protect individual privacy and the commercial interests of firms.

50. These and many other applications of ICT can reinforce or transform the structure of industries, the geographical location of economic and social activity, and the organization of firms and public-sector organizations. These technologies do not need to be passively adopted by citizens, consumers and business users. They can be shaped and adapted to

complement social and economic needs and values. This shaping process can result in a reconfiguration of technologies, but it requires financial resources and considerable technical and organizational expertise. There is therefore a need for developing countries and countries in transition to evaluate the benefits and risks of alternative technical applications for their domestic environments and to introduce policies and regulations that will protect their own priorities.

51. The successful implementation of ICTs also requires substantial organizational change. Major issues concern the security of information and its accessibility throughout organizational hierarchies. There is a need for training and retraining as the skills appropriate to traditional functions in organizations become inappropriate when ICT systems are introduced. ICTs raise fundamental issues about the nature of work and the working environment. The introduction of ICT systems often leads to reductions in the size of the workforce or to the need to employ new workers to perform jobs consistent with new ways of creating and using knowledge. In scientific and technical research communities, the training of managers, technicians and R&D personnel is a major issue. For the developing countries and countries in transition, the linkages between organizational change, the introduction of ICTs and new approaches to education cannot be overlooked. The priorities for education will differ, depending on existing capabilities and the structure and organization of educational institutions.

2.7 Shaping the ICT environment

52. In designing national strategies for ICTs, it is important to recognize that the boundary between ICT users and producers is frequently blurred. Software users, for example, play a major role in software development in sectors such as banking and petroleum, and in most manufacturing sectors. This accentuates the need to build capabilities for engaging in the design, development and maintenance of these technologies. If these capabilities do not exist, or are insufficiently available in the workforce, developing countries and countries in transition will not be able to devise creative solutions using ICTs to resolve development problems.

53. Few people, public institutions or companies are fully prepared for the global information society. Reaping the potential benefits of stronger economic growth, improved quality of life and new sources of employment, requires effective management of the transition towards this society. It involves measures to build up each country's NII and to link this infrastructure with the GII. It also involves the customization or production of ICTs that are relevant to local experiences. In India, for instance, there are examples of the job creation potential of ICTs in the software industry, where more than 350,000 people are employed.

54. To ensure that ICTs do not destroy more jobs than they create, businesses need to adapt their organizational structures and focus on human resource development. Developments such as teleworking may offer job-creating possibilities, but the new working conditions also give rise to the need for new labour legislation to protect workers. The "learning society" suggests the need for "learning companies" in which workers use ICTs to access knowledge and information to update their skills.

55. To obtain the benefits of ICTs for sharing knowledge and accessing new scientific and technical knowledge, interactive learning and new forms of education and training extending beyond the workplace, are becoming important. ICTs are supporting education and training which in some cases can be undertaken in the home, local communities, smaller companies and public service organizations.

56. A successful transition requires improved awareness in the public and business sectors, better education and improved literacy rates, user involvement in designing and implementing new services and applications,

facilitation of universal public access, and a readiness on the part of governments to assume responsibility for selecting and giving priority to a wide range of policy and practical initiatives. National governments and other stakeholders are recognizing the importance of ICTs as generic technologies with substantial potential for contributing to development goals. However, in order to achieve the benefits and minimize the risks associated with ICTs, there is a need for assessment and action at the national level as well as internationally.

3. Assessing ICTs as a basis for action

57. As the GII develops, markets in the industrialized countries for some ICT products and services are beginning to reach saturation point, and suppliers in the industrialized countries are seeking new revenue sources elsewhere. As illustrated in the preceding section, in developing countries and countries in transition, many of these products and services are only just beginning to become available and there are very large gaps between the rich and poor countries in the diffusion of these technologies. The current market conditions in the industrialized countries are opening a temporary "window of opportunity" for developing countries and countries in transition to encourage ICT production and applications that are more responsive to their basic needs and market requirements. ICT applications can play a major role in alleviating poverty, enabling new learning experiences, reducing environmental problems, encouraging cultural diversity and reducing the harmful effects of social exclusion.

3.1 Assessing the benefits and risks

58. The diffusion of ICTs is giving rise to the hope that advanced ICTs will provide the necessary tools for including the world's marginalized people in the emerging information society. Enabling them to connect with the GII will help more people and countries to realize their development potential. The application of these technologies and services can bring widespread benefits to both the business and public sectors. At the same time, however, there are fears that inequalities in the distribution of access to networks and in national capabilities to produce and use ICTs will exacerbate social and economic problems by widening the gap between rich and poor.

59. In the industrialized countries, developing countries and countries in transition, governments are initiating national strategies to stimulate production capabilities and export performance as well as the use of ICTs. It is difficult to evaluate the direct and indirect costs and benefits of these and other applications using available quantitative methods. Improved efficiency and productivity gains can arise from investment in ICT-based systems for transport and logistical systems, provision of more timely and accurate meteorological information, railway ticketing systems, as well as many other applications. Value can be added by customizing software and installing and maintaining systems in developing countries and countries in transition, even where software and hardware production capabilities are do not exist. The evidence does suggest that investment in the NII is associated with economic gains. However, models of economic impact generally do not take sufficient account of the structural problems in developing countries and countries in transition. Also, they require substantial amounts of detailed data on national production and use of ICTs on a sectoral basis as inputs to the modelling exercise, and this information is often difficult to obtain.

60. Case study evidence indicates that considerable social and economic benefits can be obtained as a result of investment in both infrastructure and human resources. Some of these benefits for the health sector, education and technical training, humanitarian relief operations, freight operations and the disabled, are illustrated in appendix 1.

61. The effective use of ICTs, however, requires as much attention to organization, education and training as to the characteristics of the technical design of these systems. If these and other issues related to financing are not addressed, there is a risk that the diffusion of these applications will result in the further exclusion and marginalization of major parts of the world's population. Effective assessment, selection and evaluation of the benefits can help to reduce this risk when the particular needs of developing countries and countries in transition are taken into account.

62. ICTs do not offer a panacea for social and economic development. There are risks of unemployment and social and economic dislocation, and these may lead policy makers to give lower priority to the need to create effective national ICT strategies. However, on the basis of the evidence, *it is apparent that the risks of failing to participate in the ICT revolution are enormous.* Failure to give priority to ICT strategies that enable developing countries and countries in transition both to develop their national infrastructures and to join the GII will exacerbate the gap between rich and poor. There is a growing need to evaluate the social and economic impacts of ICTs and to create opportunities for capacity building that will ensure their beneficial use and absorption within national economies and civil society.

63. The challenge is to use these technologies to link different parts of society, and to encourage the accumulation of experience by the excluded and most deprived groups, whose needs cannot be met by market forces. If this can be done, ICTs will play a substantial role in helping to reduce the growing income gap between rich and poor and encouraging their inclusion within the wider framework of society.

3.2 National ICT initiatives and international cooperation

64. In the industrialized countries, public and business sector resources are being used to construct the NII, to restructure hardware and software production markets, and to enable users to access vast amounts of knowledge. The ICT components of the NII are being combined with informal knowledge to enable businesses and communities to sustain economic growth and improve the overall quality of life. National initiatives include the United States Task Force on the National Information Infrastructure, the Danish INFO 2000 project, the Canadian Information Highway Advisory Council on the Information Society, consideration of the role of citizens in the European Information Society in the Netherlands, and the United Kingdom's Information Society Initiative. The Global Information Infrastructure Commission, the OECD and the European Commission are analysing and discussing new ways to exploit the social and economic benefits of advanced ICTs.

65. Representatives of the public and business sectors in the industrialized countries are shaping the GII to their own advantage and stakeholders are negotiating the "rules of the game" in every area affected by ICTs. These areas include the terms of trade in goods and services (business and cultural products), competition and regulatory policy and the conditions of market access, information security, public-sector revenue generation, standards, basic and strategic R&D, the protection of intellectual property, formal education and training, and employment conditions.

66. Developing countries and countries in transition are beginning to introduce national initiatives designed to improve the transfer of expertise from the industrialized countries and strengthen the build-up of national capabilities in the ICT sector in ways that contribute to their particular development goals. These countries are encountering the ICT revolution *from different economic starting conditions and with different social and economic resources.* There are substantial differences in their economies,

and major variations in organizational styles and cultural preferences, as well as in the capabilities needed to accumulate technological knowledge in the ICT field.

67. Developing countries and countries in transition are recognizing the importance of ICTs for their own development. National ICT strategies have already been put in place in some countries, while other countries have yet to formulate clear strategies. The African Information Society Initiative (AISI) of the United Nations Economic Commission for Africa has developed an action framework which calls for "the elaboration and implementation of national information and communication infrastructure plans involving development of institutional frameworks, human, information and technological resources in all African countries and the pursuit of priority strategies, programmes and projects".

68. The GII is stimulating discussions on an international and regional basis among industrialized and developing countries. For example, the Information Society and Development Conference in South Africa (ISAD) in 1996 provided an opportunity for G-7 and other industrialized countries to discuss the issues with developing countries and countries in transition. In these discussions, it was clear that conditions in developing countries and countries in transition differ from those in industrialized countries and that the particular needs of the former should be taken into account if they are to benefit from access to the GII.

69. All these initiatives stress the importance of action leading to stronger public and business sector partnerships which can share the challenges and costs of developing the NII and achieving GII connectivity in ways that support development goals. The transfer of ICTs to developing countries and countries in transition requires strategies that harness the strengths of these countries and link investment in ICTs and human resources to development objectives. Thus, national ICT strategies need to be linked explicitly to development priorities.

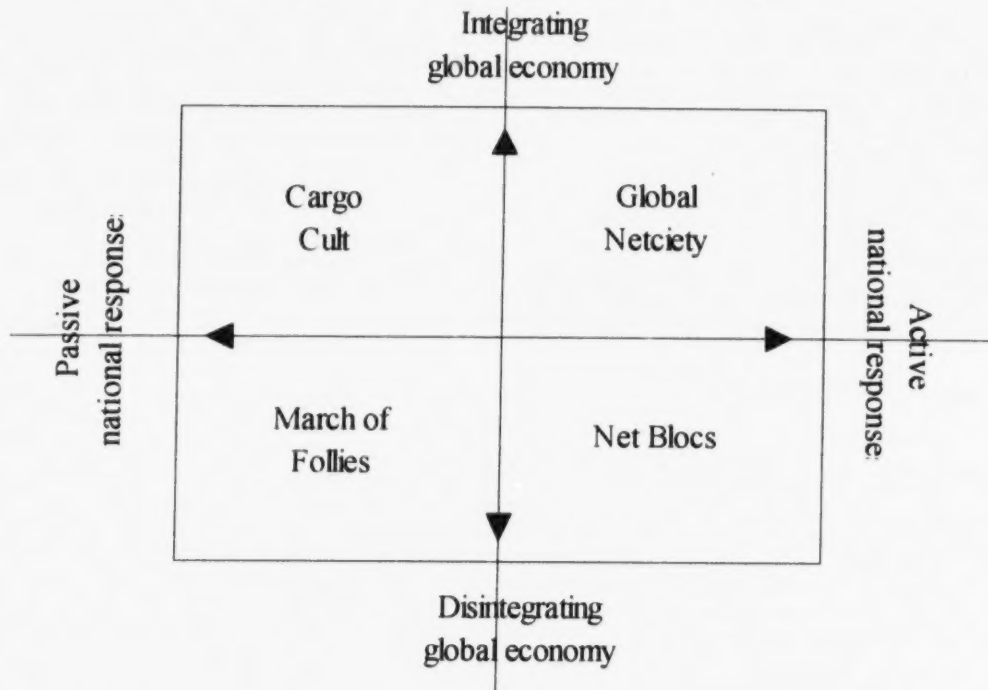
70. The national and international policy and regulatory framework influences the selection of ICTs and creates the environment which shapes their use. A national ICT strategy should encompass policies and regulations that strike a balance between applications in terms of commercial priority and applications in areas where market forces are unlikely to work effectively. The policy and regulatory framework can be used to ensure that competition in the market is more effective, to protect against any excesses of monopolization, to promote universal service goals, to preserve diverse cultures and to protect consumer rights. The framework that is appropriate may differ in each country depending on the structure of its domestic market, the barriers to entry and the opportunities for innovative developments. National ICT strategies have to be developed within the framework of the global economy. In order to better understand the way the global environment is likely to change over the next decade, the Working Group considered alternative visions of the role of ICTs in the development process and the possible responses of national governments and other stakeholders.

4. Visions of ICTs for development

71. Constructing visions or scenarios about how ICTs will be configured and used in the future is a very challenging task. The future is contingent on global economic developments as well as on local and national social, cultural, political and economic initiatives. Scenarios create stories about the future and are helpful in identifying the problems that will need to be addressed if the maximum benefits are to be derived from the ICT revolution. Furthermore, they offer a basis for designing policies and strategies to adapt to unpredictable events and create a desired future.

72. Some of the members of the Working Group participated in a joint IDRC/CSTD workshop which enabled participants to discuss possible scenarios for the global information society. The four scenarios shown in figure 2 emerged from the discussion; they focus on how the ICT revolution might reshape the development process over the coming decade. The scenarios provided a basis for further discussion among members of the Working Group about the design of policies and strategies that are needed to enable developing countries and countries in transition to adapt to unpredictable events and create a desired future.

Figure 2. ICT scenarios for 2005



73. In these scenarios, the global environment shown on the vertical axis in figure 2 may be enabling and more inclusive, leading to open communication technology standards and universal access to communication networks. Alternatively, it may be dominated by a few powerful companies, resulting in increased concentration of technology, capital, wealth and power within the industrialized countries. The result would be a disintegrating global economy characterized by continuing monopolization and oligopolistic market structures in many areas of the ICT sector.

74. In either of these global environments, the governments, private sector firms and non-governmental organizations in developing countries and countries in transition may adopt a passive stance over the next decade and fail to introduce policy initiatives that would promote the use of ICTs to meet development goals, as suggested by the horizontal axis in figure 2. Alternatively, a wide range of active national responses could result in the build-up and accumulation of technological capabilities in these countries.

4.1 Global ICT scenarios for 2005

Cargo Cult

This scenario envisages the emergence of an integrated global environment. However, developing countries and countries in transition might adopt a passive stance towards the global economy, believing that the market will yield products that bring wealth and an improved quality of life. This scenario is reminiscent of the so-called cargo cult phenomenon among Pacific islanders after the Second World War. In this scenario, a world-wide communication infrastructure becomes widely available as international equipment and service suppliers promote its extension in their bid to develop new markets. Affordable access is promoted, in part, by coordinated non-governmental organizations whose threats of action finally convince private sector investors to extend networks to embrace the formerly excluded populations of the world. However, the passive policy stance of most national governments results in a failure to adapt the new infrastructure and services to local circumstances. The acquisition of ICTs is regarded as important, but little effort is made to adapt these technologies to the particular needs of the developing countries and countries in transition or to initiate a broad process of social learning that would further development goals. The result would be a widespread sense of futility, frustration and unrealized hopes in many parts of the developing world.

March of Follies

In this scenario, a narrowly self-interested global ICT industry flourishes, and is met by a passive response on the part of developing countries and countries in transition. Despite the decreasing costs of computing power and communication, access to the GII is extended only to those who are willing and able to pay for the content. These developments are accompanied by a growing concentration of power in the hands of new multimedia enterprises based in the industrialized world. The diffusion of ICTs also leads to a massive increase in computerized crime and surveillance in "cyberspace" becomes commonplace. Although ICT applications diffuse rapidly, their social and economic impact is divisive and the gap between rich and poor continues to grow. These developments fragment the global economy as new growth poles arise organized around large urban centres which are interconnected and share the same technologies, work, language and cultural interests. Many recognize that only a minority of people are benefiting from the ICT revolution, but national governments do not have the financial resources to introduce active policies that would promote the accumulation of technological capabilities and the use of ICTs in support of sustainable development goals. Some governments, in fact, might introduce policies that reduce the potential for integrating global and local businesses. Some members of the Working Group referred to this as the "doomsday scenario".

Global Netciety

The features of integrating global ICT structures are coupled in this scenario with active national policies and coordinated action with the private sector and the non-governmental organization community. This creates the conditions for the beneficial use of ICTs to meet development goals. In this scenario, the rapid diffusion of ICTs provides a basis for a renewed search for positive human values and the recognition that these technologies embody opportunities for individual and collective social and economic growth. An international coalition moves to demonstrate the development

potential of ICTs, and measures are taken by international organizations, national governments and local businesses to remove barriers to access to the global information society. ICT projects are implemented to assist the poor and the marginalized populations of the world, and there is a self-reinforcing "virtuous spiral" of diffusion ensuring that increasing numbers of communities participate in the NII and are linked to the GII, and that new capabilities are used to respond to development needs.

Net Blocs

In this scenario, the global environment is assumed to be characterized by relatively narrow self-interest in the industrialized world. The emergence of new growth poles gives rise to continuing tensions and to the emergence of a new dynamic equilibrium in the global economy. Within this context, governments and businesses in the developing countries and countries in transition take initiatives to develop ICTs to meet their own needs and conditions by creating alternative ICT systems. These are locally successful, but not well integrated with the leading ICT systems of the industrialized world. This generates a slow but dynamic process of social and economic transformation that leads to improvement in some regions of the world as governments and enterprises in the newly industrializing countries of Asia and Latin America use ICTs to achieve a more pluralistic and culturally diversified world. These ICT systems compete effectively in international markets by creating blocs of interconnection with other developing countries and countries in transition. Because each competing ICT system has a more limited market and a smaller range of information to build on, the benefits of ICTs are not widely shared. Also, economies tend to trade and interact more narrowly between regions, rather than globally. This is a very dynamic and creative scenario in many ways; but it is also unstable, because of competitive quarrels and the limits of ICT diffusion and access.

75. In the Global Netciety scenario, an integrating economy emerges from the creative connection of global ICT systems. As shown in the upper right-hand box of figure 3, if the "rules of the game", including intellectual property rights, standards and tariffs for access to global networks, are put in place for the GII on a highly cooperative basis, and if competitive forces are strong, then a balanced environment of competition and cooperation among ICT companies will emerge. The Global Netciety scenario might emerge in which there would be opportunities for all countries to build their NIIs and to derive mutual benefit from the GII. In contrast, if there is a low level of cooperation in the establishment of the "rules of the game", and if competitive forces are weak, then national governments may be more likely to adopt a relatively passive stance, which is characteristic of the Cargo Cult scenario. In this scenario, they would be able to do little more than respond to global conditions.

76. In the March of Follies and Net Blocs scenarios, however, global conditions bring the benefits neither of fully competitive markets nor of a high level of cooperation in establishing the new "rules of the game". Monopolistic or oligopolistic firms would continue to dominate the global ICT sector. In the March of Follies scenario, national policies would not be put in place to counter problems created by the absence of a high level of cooperation in introducing the new "rules of the game" and a highly monopolistic global environment would emerge (lower left-hand box in figure 3). However, if there is a relatively low level of competition resulting in oligopolistic competition which is combined with a high level of cooperation in establishing the new "rules of the game", then national governments are likely to introduce active policies and strategies leading to regulated oligopoly (lower right-hand box in figure 3). In this case, the Net Blocs

scenario is more likely as governments design national ICT strategies to maximize the social and economic benefits of ICTs, especially for some of the world's disadvantaged populations.

Figure 3. Global Competition and the New 'Rules of the Game'
Rules of the game - Cooperation

		Low	High
Competition	High	Free market	Competition and cooperation
	Low	Monopoly	Regulated oligopoly

Source: Adapted from E. Wilson (1996). Presentation to the UNCSTD Working Group on IT & Development, Horsted Place, December, mimeo.

4.2 Active ICT strategies for the national information infrastructures

77. In the discussion among the Working Group's scenario team, the participants' own values converged on the Global Netciety scenario. In this scenario, global cooperation would emerge through the process of building new forms of two-way partnerships between developing countries and countries in transition, and the industrialized countries. The members of the scenario team regarded this scenario as possible only with considerable luck and the introduction of shared medium-term policies.

78. The Net Blocs scenario was regarded by the team as being a more realistic outcome by the year 2005. In this scenario, ICT producers in the industrialized countries and a few developing countries would expand and deepen their markets. However, national governments and other local actors would actively create "spaces" and opportunities for ICT businesses and public-service applications defined along more diverse lines. The outcomes of this scenario would be unstable and there would be a risk that many developing countries and countries in transition would be shut out of the global ICT system by cost, or that they would opt out because the products or services produced by that system were unresponsive to their development needs.

79. The Net Blocs scenario, like the other scenarios, tells a story about a world that cannot be fully controlled and which may not emerge. However, because it represents a world in which active national policy measures are introduced and ICT strategies are designed by national governments, the public sector and the business community, the Working Group chose to focus on this scenario. Awareness of opportunities created by the instability of the Net Blocs in an increasingly integrating global environment helped the Working Group to focus on initiatives to minimize the risks of a

disintegrating global economy through the introduction of appropriate compensatory or corrective policies. The climate of oligopolistic competition in the global market in this scenario offers the possibility of designing national ICT strategies that should enable developing countries and countries in transition to build and extend their capabilities to control the diffusion and use of ICT applications in the interests of a sustainable development process.

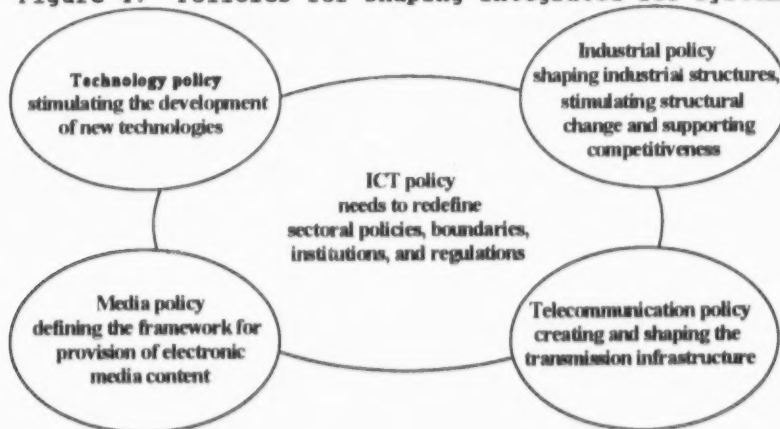
80. The principal questions for developing countries and countries in transition as they move to develop their NIIs and to connect with the GII are the following. What economic, political and social resources can be used, even by the poorest countries, to develop their distinctive NIIs and to join the GII in a way that maximizes the social and economic benefits for these countries? How can these resources be extended as a result of new partnerships between the public and business sectors? What are the most effective roles for national governments and other stakeholders? What role can the agencies of the United Nations system play to facilitate and complement the emergence of active national ICT strategies? The Working Group's recommendations and guidelines are outlined in section 5.

5. Towards active national ICT strategies and strengthened international cooperation

81. The review of national experiences carried out by the Working Group has convinced it of the value of each country's formulating a strategy for its production, acquisition and use of ICTs. Each national strategy will be unique, responding to the particular economic, social and cultural values, realities and goals.

82. There is a need for policies and strategies that will enable developing countries and countries in transition to shape and build up their NIIs around an integrated ICT structure as suggested in figure 4.

Figure 4. Policies for shaping integrated ICT systems



Source: Prepared by German Development Institute, Berlin, 1996 for the UNCSTD Working Group on IT & Development.

83. Effective national ICT strategies should support the introduction of new regulatory frameworks, promote the selective production and use of ICTs and harness their diffusion so as to contribute to the development of human resources through education and interactive learning and improved management of organizational change in line with development goals. ICT strategies and policies linked to development objectives need to redefine sectoral policies, institutions and regulations, taking into account the need to be responsive to the convergence of telecommunication, audio-visual and

computing technologies. Strategies need to be devised to secure new means of financing ICT investment, strengthening indigenous scientific and technological research capabilities, and helping to improve each country's capacity to participate in the formulation and assess the impact of the new international "rules of the game" that are being established in international and regional fora.

84. National ICT strategies are needed which encompass initiatives at the local community, municipal, regional and national levels and actively encourage a "development dialogue" within and between developing countries and countries in transition. New initiatives are needed to build and extend the capabilities of people who can implement training programmes, assess and select the ICTs that are most responsive to each country's needs, evaluate the impact of new ICT applications and services, and target user communities that should receive priority attention.

5.1 Recommendations

85. To strengthen the accumulation of national capabilities leading to greater preparedness for harnessing ICTs in support of development goals, the Working Group:

Recommends that each developing country and country in transition establish a national ICT strategy. Where such strategies already exist, they should be reviewed to ensure that they take note of the guidelines proposed by the Working Group of the CSTD;

Recommends that immediate action be taken by national governments to establish a task force or commission or to ensure that another entity is charged with establishing the guidelines for their national ICT strategies. Reviews should be undertaken over a six-month period and a report should be prepared outlining the priorities of each country's national ICT strategy, the mechanisms for continuous updating, and the procedures for implementation of the components of the strategy. Progress on the implementation of this recommendation should be reported to the next session of the Commission in 1999;

Recommends that each agency of the United Nations system review the financing, production and use of ICTs for social and economic development in its area of responsibility. This review should monitor the effectiveness of new forms of partnerships in the ICT area, and address the capability of each agency to provide technical assistance in that area. This needs to happen so that the United Nations system can be in the forefront in helping developing countries and countries in transition to implement their national ICT strategies;

Recommends that UNCTAD prepare a study for the next session of the Commission on the implications of new forms of revenue generation, focusing especially on those involving ICTs which may support social and economic development priorities. In particular, it should report on the implications for developing countries and countries in transition of the ongoing discussions and studies on a "bit tax".

86. The Working Group's suggested guidelines for national governments and agencies and organs of the United Nations system are set out in the following sections. Effective national ICT strategies aimed at national capacity building for the NII will involve many stakeholders from the public and business sectors, and the guidelines encourage new partnerships in many instances. Multinational companies, the governments of the OECD countries and those of the newly industrializing countries, regional groupings, bilateral donors, and multilateral and regional financial institutions, will need to provide external resources which can be combined with domestic resources through strengthened national ICT strategies. All developing

countries and countries in transition should note these guidelines in developing and strengthening their national ICT strategies.

5.2 Guidelines for national ICT strategies

87. There is considerable potential for producing and using ICTs for economic and social development. The following guidelines were developed by the Commission. They are not meant to be comprehensive but are illustrative of measures which will need to be addressed in developing a national ICT strategy.

Producing and using ICTs to social and economic advantage

88. ICTs have huge potential for creating economic and social benefits for all citizens. They also have the potential for widening the gap between rich and poor. To ensure that the benefits outweigh the disadvantages, it will be necessary for governments, the business sector and civil society to work together. The following guidelines indicate some of the ways in which this can be achieved.

Suggested guidelines

National governments and other stakeholders should ensure that:

- ICTs are used to satisfy the basic needs of all the population and that their production and use contributes to economic and social objectives;
- Technology assessment procedures and methodologies are introduced to help identify and select key ICT production sectors and to promote key user initiatives. Feasibility, cost-effectiveness and the expected contribution to development priorities should be included as explicit selection criteria. Evaluation methods should also be strengthened;
- Particular attention is given to promoting innovations in ICTs, especially in hardware, which can be implemented in ICT systems that are used in areas without, or with unreliable sources of, electricity and under difficult climatic or geographical conditions;
- Measures to promote and strengthen the social and cultural diversity of content accessed via the NII and to stimulate the production of indigenous content in selected areas are included in national ICT strategies;
- Measures are taken to provide access to public information of relevance to citizens and community groups. Such measures might include promoting public awareness of ICT applications and the potential of databases, as well as ICT demonstration projects;
- Where appropriate, ICT applications are used to encourage interactive relationships between governments, local authorities and citizens, and within citizen groups.

Developing human resources for effective national ICT strategies

88. The new ICTs are changing rapidly and new applications are being created daily. These changes lead to continuing changes in skill requirements. Fortunately, they also provide new ways of creating those skills. They provide the means for enabling lifelong learning and for

improved education, which itself can lead to improved quality of life. A national ICT strategy should devise ways in which governments, businesses and civil society can complement each other in using the new technologies to enhance skills and education in a continuing way. Lifelong learning must also apply to the informal sector.

Suggested guidelines

National governments and other stakeholders should ensure that:

- The use of ICTs is encouraged at all levels of the formal education sector and, where appropriate, special attention is given to literacy, training, language skills and primary education;
- Education and training programmes include scientific and technical skills, policy analysis skills and innovation management skills relevant to the effective production and use of ICTs, and incorporate specific plans for curriculum revision to introduce professional knowledge that is relevant to both the production and the use of ICTs in support of development goals;
- Curriculum revisions include training in methods of technology assessment, in creative approaches to ICT development, and in maintenance and adaptation to local conditions, as well as training in evaluating the viability and sustainability of export-oriented strategies and complementary measures;
- Curriculum revisions take into account the need for gender-specific training and education regarding the design and application of ICTs;
- Measures are introduced to address job creation and working conditions which will contribute to sustainable livelihoods and the promotion of new skills acquisition through new forms of ICT-based interactive learning;
- The job creation potential of ICTs is explicitly addressed through employment measures linked closely with education and training policies.

Managing ICTs for development

89. The evidence from the introduction of ICTs into development programmes suggests that successful programmes require new organizational forms. Successful management requires that these organizational changes be identified and implemented. The changes accompanying the diffusion of ICTs create the need for people who can act as intermediaries able to coordinate, integrate and disseminate new information about the production and use of ICTs drawn from relevant scientific and technical research and the practical experience of ICT implementation in a variety of organizational settings. The management of ICTs for development requires that knowledgeable people and ICT applications be combined in ways that support national development priorities.

Suggested guidelines

National governments and other stakeholders should ensure that:

- Measures are taken to improve the "management of change" in all organizational settings;

- Mechanisms are introduced to compare the management processes adopted in different countries and to assess their strengths and weaknesses;
- The process of customizing ICTs for more effective use, especially by the least developed countries, marginalized groups in rural areas, and women, is given special attention;
- Measures that encourage continuous organizational learning-by-doing, learning-by-using and learning-by-interacting are included in national ICT strategies.

Accessing ICT networks

90. There are area risks of social exclusion if businesses and citizens do not have access to an adequate NII. The NII needs to be designed so as to manage those risks. Regulatory frameworks can help to promote the efficient use of private investment to extend and upgrade the NII in line with development priorities and to ensure integration with the GII. They can also be used to encourage the development of an NII that is responsive to the needs of different users, including the poorest sectors of the population and specific communities such as women's groups.

Suggested guidelines

National governments and other stakeholders should ensure that:

- Clear plans are devised for regulatory frameworks for telecommunication, broadcasting and cable television. Regulatory frameworks should ensure that minimum standards are in place to achieve network interoperability within countries and GII connectivity;
- Regulatory measures are devised to address bottlenecks impeding effective competition, created by unfavourable market structures;
- Regulatory measures take account of national social and cultural priorities as well as economic efficiency considerations in licensing domestic and foreign operators.
- Universal service measures and related policies are developed, and measures to ensure that suppliers take account of a wide range of user needs are evaluated and introduced;
- Special attention is given to street-side "kiosks" in rural and some urban areas to provide access to networks and services that are responsive to people's needs. National ICT strategies should include measures to explore innovative financing arrangements involving public and business partnerships.

Promoting and financing investment in ICTs

91. Market mechanisms alone are unlikely to be sufficient to generate adequate investment funds for developing countries and countries in transition that are seeking to upgrade their NIIs. Governments are experimenting with two-way investment partnerships between local and foreign firms that lead to new ICT applications and generate spin-offs throughout the economy. However, these initiatives require a pooling or coalition of resources from the public and business sectors; but this mechanism has yet to be fully exploited.

Suggested guidelines

National governments and other stakeholders should ensure that:

- Plans are introduced that encourage a coalition of resources to initiate ICT production in key areas and to provide a basis for experimental and commercial ICT applications;
- Innovative financing arrangements are considered that bring together financial and human resources as well as technical contributions "in kind" to provide seed capital for innovative projects;
- Priority is given to measures to attract foreign investors to ensure the development of the NII, including the telecommunication infrastructure, ICT applications involving software development and human resource training. Such measures may include new forms of revenue generation and public and business partnerships to strengthen national capabilities in manufacturing, and the adaptation and customization of ICTs;
- The implementation of innovative pricing schemes is encouraged, leading to stimulation of demand for commercial services and exploration of means whereby the most marginalized groups in society can access and use the NII.

Creating and accessing scientific and technical knowledge

92. If developing countries and countries in transition are unable to build their own NIIs or be part of the GII, they will be handicapping their scientific and technical research communities. Capacity building in the ICT field involves the accumulation of scientific and technical knowledge that enables the assessment, selection, application, adaptation and development of ICTs in ways that contribute to equitable and sustainable development. The coordination of, and access to, expertise within, and external to, developing countries and countries in transition need to be strengthened. Improved "early warning systems" regarding new technical, market, policy and regulatory developments are also needed.

Suggested guidelines

National governments and other stakeholders should ensure that:

- Science, technology and innovation policies are formulated in the light of the new opportunities generated by ICTs;
- Measures encourage and facilitate the establishment of R&D networks linking ICT production and use to priority development issues;
- Collaboration among science and technology research groups involved in the development and application of ICTs in developed and developing countries is encouraged;
- Plans are developed and implemented for the dissemination of information on R&D networks, including promotion of the use of ICTs to support these networks, e.g. the establishment of World Wide Web pages on the Internet;

- Special attention is given to ensuring close interaction with end-users and particularly with marginalized and special interest groups in rural areas;
- Explicit measures are taken to encourage "knowledge broker" organizations that facilitate the generation and application of scientific and technical knowledge by combining locally relevant expert advice with information acquired through using ICT applications.

Monitoring and influencing the "rules of the game"

93. The international agreements, regulations and protocols governing the GII are influenced to a large extent by the governments of the industrialized countries and companies based in those countries. The "rules of the game" particularly apply in areas such as standards, intellectual property rights, security, regulation and trade. Developing countries and countries in transition have inadequate resources to participate fully in setting these rules, and they may be disadvantaged as a result.

Suggested guidelines

National governments and other stakeholders should ensure that:

- Mechanisms are put in place to strengthen participation in multilateral and regional fora involving the public and business sectors;
- Measures are taken to support monitoring and analysis of developments in these fora that affect the potential for the production of ICTs in the national context;
- Special attention is given to monitoring and analysing the impact of developments in international or regional fora that affect the transfer, customization and use of ICTs in domestic markets;
- The emerging "rules of the game" are assessed particularly to ensure that new competitive and cooperation opportunities are recognized and initiatives taken to benefit from them.

5.3. Guidelines for the United Nations system and ICTs and development

94. On behalf of the UNCSTD Working Group, a review was conducted by UNCTAD of the ICT-related activities of the agencies of the United Nations system. These agencies play an important role in facilitating the development of national ICT strategies and in supporting practical programmes for ICT production and use. Six broad areas of current activity were identified: the application of ICTs in developing countries at national, regional and community levels, often linked to United Nations-sponsored technical cooperation programmes; local capacity-building, mainly in terms of upgrading infrastructure, including supporting telecommunication network upgrading programmes in low-income countries, and facilitating access to ICTs; research, mainly on ICTs and development, the ICT revolution, the social and economic impact of ICTs, and ICTs in relation to the specialized areas of competence within the United Nations system; facilitating connectivity to global networking; software development focusing on the needs of developing countries and countries in transition; and creating databases for use by countries or the United Nations organizations themselves in planning development programmes. Support is provided through advisory services and contributions to national capacity

building, which help to facilitate efforts to strengthen NIIs. United Nations agencies are active in ICT policy and strategy formulation, providing expertise to interested countries or interested parties within countries.

95. These activities vary from one agency to another and in-depth reviews will be necessary to assess fully the extent to which each agency's activities adequately address the needs and requirements of developing countries and countries in transition. Nevertheless, as an international body with analytical capacity, the United Nations is in a unique position to identify the policy, institutional, legal and regulatory changes needed to create a national ICT strategy. Its activities can also facilitate access to the GII by helping to establish networks which allow users in developing countries and countries in transition to access information, clients and resources world-wide.

96. The UNCTAD review revealed considerable differences in the way, and the extent to which, individual agencies are using ICTs to improve their internal efficiency. There is a need to optimize the use of these technologies in technical assistance programmes in order to help developing countries and countries in transition to gain access to the GII. The ICT development lessons need to be learned from each agency's experiences and this knowledge needs to be disseminated more widely.

97. The adoption of national ICT strategies by developing countries and countries in transition will lead to changed development priorities and needs. The United Nations system will need to ensure that it is in a position to respond to requests for assistance in these new activities.

Suggested guidelines

The agencies and organs of the United Nations system should:

- Review their own use of ICTs in achieving greater efficiency in their operations. United Nations system use should match that of the business sector and national governments;
- Review their own capabilities in using ICTs for development activities relevant to their mandates, and upgrade these capabilities as necessary in order to support national efforts to strengthen local ICT capabilities;
- Implement measures that enable the wealth of knowledge and experience within the United Nations system regarding the use of ICTs for social and economic development to be systematized and disseminated in a much more vigorous way. A percentage of the resources for each project should be devoted to learning the development lessons and to disseminating this knowledge.

Appendix 1: Selected examples of ICT applications

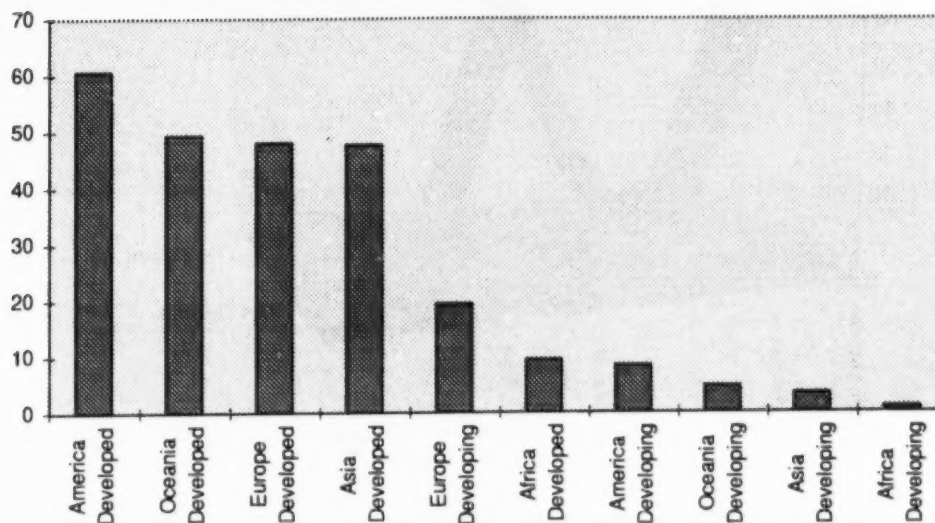
- In Zambia, a project set up jointly by the University of Zambia Medical Library and the University of Florida twinned the two libraries using e-mail and low-orbit satellites. Overcoming the shortage of material available in Zambia, students and staff at the University were able to access health literature and information not held in their library. (Source: IDRC)
- HealthNet Senegal is part of a global network which extends to almost 30 countries. Users of the network are national and international non-governmental organizations, hospitals and other medical facilities, medical schools, medical libraries and government agencies. The network helps to combat the isolation of health workers and the lack of information which impedes their work. They can communicate with other health professionals locally, regionally and internationally, thereby stimulating "North-South", "South-North" and "South-South" dialogue and exchange of information. (Source: IDRC)
- In Brazil, poor and isolated communities are integrated with the help of computer schools, set up by volunteers in slums, using donated equipment. Any type of organization is allowed to participate, provided that it is accepted by the group and has no involvement in illegal activities such as the drugs trade. The computer schools are established in association with existing communities such as Catholic groups, women's groups and environmental groups. Members acquire computer literacy and are offered the possibility of closer social integration. (Source: INTECH)
- In Brazil, blind Portuguese and Spanish speakers have access to the Internet using a low-cost voice synthesizer so that they can hear information as they type or determine what information is stored in the computer. Blind people are able to increase the range of jobs they are able to do, such as programming, telemarketing and creating their own companies, as well as to access education materials. (Source: INTECH)
- In India, telephone density was increased as a result of the telecommunication restructuring aimed at connectivity, accessibility and rural expansion. Telephone operators emerged in rural areas taking advantage of the telephone connection providing services to customers and creating employment opportunity for others. Users of the telephones were able to improve their own business activities by receiving information on prices for their goods from nearby markets, monitoring the movement of trucks and arranging servicing and repairs. (Source: S. Pitroda)
- The Integrated Regional Information Network of the United Nations Department of Humanitarian Affairs allows information exchange with the humanitarian community in the Great Lakes region of Africa. The many refugees in this area require humanitarian relief and rehabilitation, which are supported by the use of ICT for better information management. The network relies on the use of the Internet, fax, satellite communication, high-frequency radio and telex. (Source: IDRC)
- In Central and Eastern European countries, telematics systems and services are being evaluated to support freight operations. The

information that accompanies the physical movement of goods is to be shared more efficiently by players in the transport chain, providing interfaces to logistics, customs and other relevant authorities, and special attention is being given to the transport of hazardous materials. (Source: European Commission)

- In Chile, the Food and Agriculture Organization (FAO) opened small information centres providing full Internet access, located in the offices of farmers' organizations and non-governmental organizations, to address the identified information needs of small-scale producers. The FAO provided training to the staff of the host organizations and to farmers, and the latter are able to access locally relevant information which is disseminated to the network of users. This includes data on crops, international crop status and market timing, prices and weather, technical and training information, and information about the organizations that support their work. The farmers use e-mail to communicate with other farmers' organizations in Chile and elsewhere in Latin America, and also with world-wide Spanish-speaking Internet users. The information centres are beginning to extend their service to the non-agricultural community, such as youth groups and social service agencies. (Source: UNCTAD)
- The United Nations Office of Outer Space Affairs uses ICTs in pursuance of its mandate to assist member countries in applying space science and technology (in particular satellite technology) to further economic and social development. An example of this is the Cooperative Information Network linking scientists, educators and professionals in Africa (COPINE) project. This satellite-based information system allows computer file transfer, interactive data transfer, and document, imagery and video transmission, to facilitate video conferences, distance teaching and tele-medicine. Its application is particularly directed at health care, agricultural research and development, management of natural resources, the environment, education, and science and technology. (Source: UNCTAD)
- In India, funding provided by the UN INTERACT initiative enabled the setting up of the government-owned Computer Maintenance Corporation (CMC). In the early stages, the company concentrated on the assembly of imported computer components, maintenance and requirement specifications for low-end manufacturing of components. With the combination of technical knowledge and relevant experience acquired through operating in the private sector, CMC was able to diversify into software development and consultancy. It now provides systems implementation and training for a diverse range of complex computer systems world-wide, which have contributed substantially to the developing world. In Singapore, the software costs involved in implementing a computer-controlled airfield lighting system were recovered within two years of its inception. Computerized freight management in ports and handling of container traffic in a number of industrialized and developing countries also rely on CMC. Through automation of the passenger reservations system of the Indian Railways - which move the equivalent of the population of Belgium every day - the ticket-issuing procedure was reduced to a matter of minutes per reservation, whereas it had previously taken several days. (Presentation by J. P. Narayan, CMC Ltd, Lonavla)

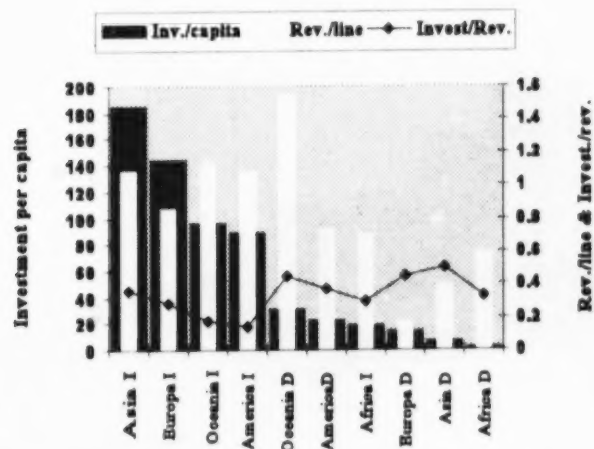
Appendix 2: Selected indicators of ICT Applications

Figure A.1. Main telephones per 100 population, 1994



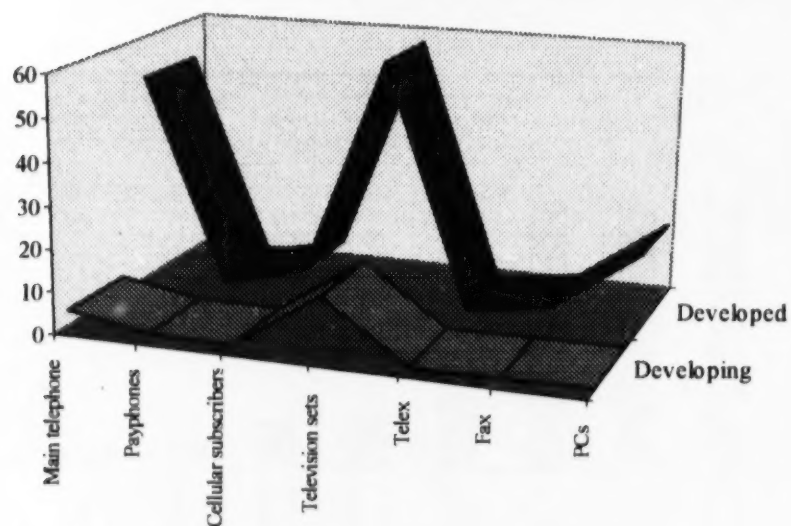
Source: UNCTAD, based on ITU data.

Figure A.2. Indicators of infrastructure development, 1994



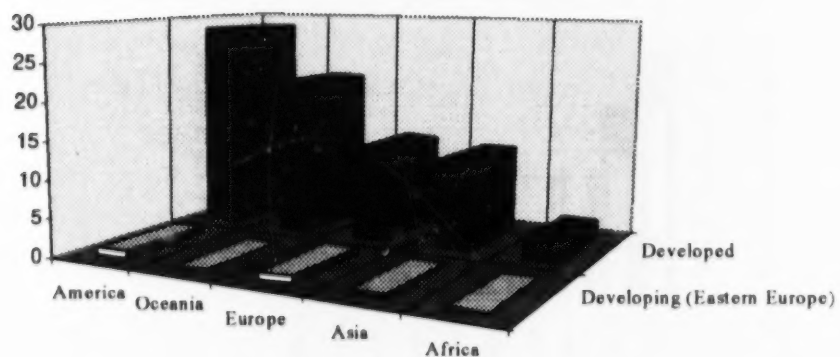
Source: UNCTAD, based on ITU data.

Figure A.3. The ICT gap, 1994
(penetration per 100 population)



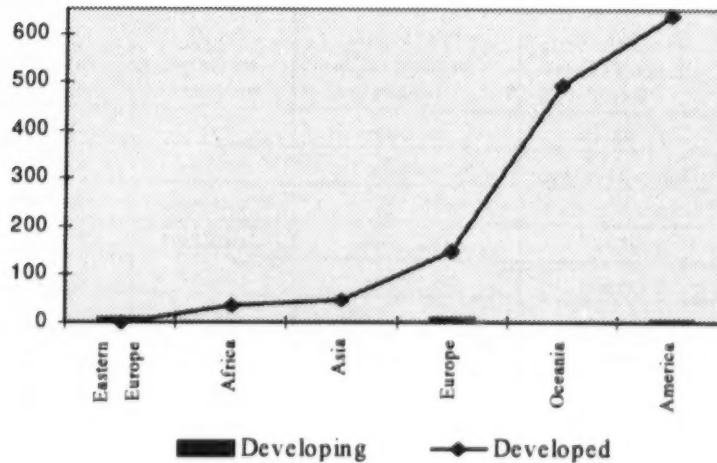
Source: UNCTAD, based on ITU data.

Figure A.4. PCs per 100 population, 1994



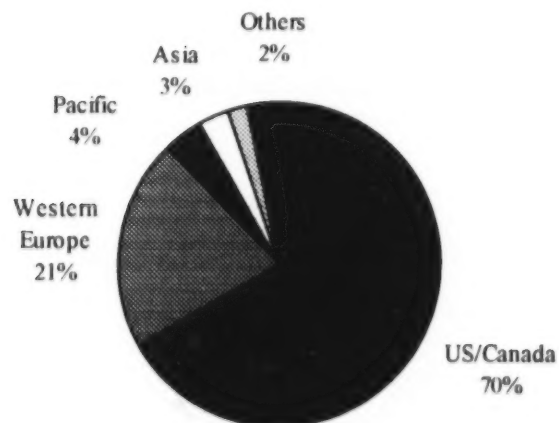
Source: UNCTAD, based on ITU data.

Figure A.5. Estimated internet use 1994
(per 10,000 Population)



Source: UNCTAD, based on ITU data.

Figure A.6. Internet hosts by region, January 1995



Source: The Internet Society, 1996

Table 1. Communications in Central and Eastern European Countries

	International Transmission Speed	National Transmission Speed	Inter- national Protocols	National Protocols	Number of computers connect to the Internet
Belarus	19.2Kbps	19.2Kbps	TCP/IP	TCP/IP	5
Bulgaria	9.6Kbps/19.2Kbps	9.6Kbps	TCP/IP	TCP/IP	608
Cehia	256Kbps/512Kbps	19.2Kbps/256Kbps	TCP/IP	TCP/IP	14 796
Croatia	64Kbps	ATM 155M	TCP/IP	TCP/IP	2 881
Estonia	256Kbps	19.2Kbps	TCP/IP	TCP/IP	2 389
Hungary	64Kbps/2M	64Kbps/256Kbps	TCP/IP	TCP/IP	11 339
Latvia	128Kbps	19.2Kbps/2M	TCP/IP	TCP/IP	820
Lithuania	64Kbps	19.2Kbps	TCP/IP	TCP/IP	263
Poland	256Kbps/3M	64Kbps/128Kbps	TCP/IP	TCP/IP	15 269
Romania	64Kbp/256Kbps	9.6Kbps/14.4Kbps	TCP/IP X.25	TCP/IP	714
Russia	64Kbps/10M	..	TCP/IP	TCP/IP	3 747
Slovakia	64Kbps/128Kbps	19.2Kbps/64Kbps	TCP/IP	TCP/IP	2 157
Slovenia	64Kbps/2M	64Kbps/2M	TCP/IP X.25	TCP/IP	2 881
The former Yugoslav Rep. of Macedonia	64Kbps	..	TCP/IP	TCP/IP	29
Ukraine	14.4Kbps	14.4Kbps/19.2Kbps	TCP/IP	TCP/IP	1 303

Source: Adapted from European Commission data by the Ministry of Research and Technolgy, Romania, 1996.

Note: ATM = Automated Teller Machine
 Kbps = Kilobites per second
 M = Million
 TCP/IP = Transmission Control Protocol/Internet Protocol
 .. = not available

**Appendix 3: List of Working Group members and
lead technical institutions**

Working Group members:

Professor Dr. B.M. Rode	Austria
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Mr. Luk Van Langenhove	Belgium
Ms. Renate Stille	Brazil
Mr. A. Gonzalez	Chile
Mr. Wang Shaoqi	China
Dr. F. Chaparro (Co-chair)	Colombia
Dr. Eugenia Flores	Costa Rica
Mr. Shume Tefera	Ethiopia
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Dr. V. Ramesam	India
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Lead technical institutions

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Institute for Development and Research Cooperation (IDRC)	Canada
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